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(11)

EP 3 300 230 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.03.2018 Bulletin 2018/13

(51) Int Cl.:
H02K 21/14 (2006.01)

(21) Application number: **17781717.8**

(86) International application number:
PCT/CN2017/071846

(22) Date of filing: **20.01.2017**

(87) International publication number:
WO 2017/177740 (19.10.2017 Gazette 2017/42)

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

MA MD

(30) Priority: **12.04.2016 CN 201610225218**

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(54) **PERMANENT MAGNET MOTOR**

(57) The present disclosure discloses a permanent magnet electric motor, which is a radial flux electric motor, consisting of a stator and a rotor, wherein an inner circle of the stator is provided with N stator teeth evenly in circumferential direction, each of the stator teeth is wound by a coil, and the N coils form stator windings, wherein, the N is an integer not less than 12. Additionally, the number of magnetic poles of the rotor is not less than 12 so that widths and the centrifugal forces of the magnets under each of the magnetic poles are limited, thereby facilitating the high speed operation of the electric motor and improving the safety. The stator is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is an amorphous magnetic conductive material, whose power loss in an alternating magnetic field is lower than that of silicon steel, which hugely increases the efficiency of the electric motor.

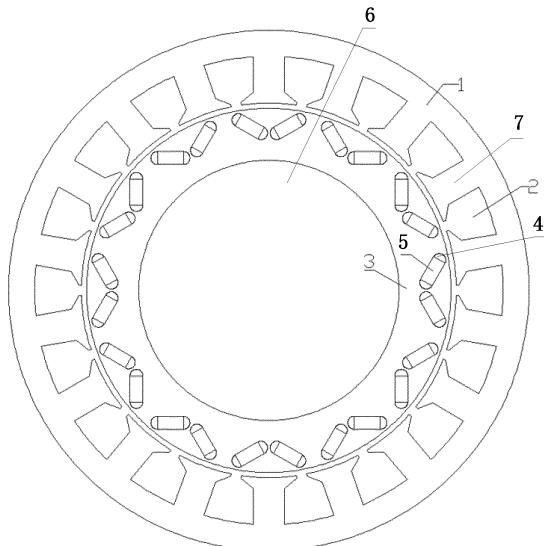


Fig. 1

Description**TECHNICAL FIELD**

[0001] The present disclosure relates to the field of electric motors, and in particular to a permanent magnet electric motor.

BACKGROUND ART

[0002] The presently commonly known structure of the electric motors used for vehicles consists of a stator, a rotor, a rotating shaft, a machine base, etc. The stator is generally manufactured by laminating cold rolled silicon steel sheets with preformed slots, and installing windings into the slots. However, the magnetic conductive materials of the stators generally have power loss in an alternating magnetic field, and the numerical value of the power loss when silicon steel sheets serve as the magnetic conductive material is very large. Especially at the high speed operating range, the power loss even exceeds a half of the sum of the electric motor power loss, which results in a relatively low efficiency of the electric motor, and affects the operation safety. The electric motors with the traditional structures, in order to reduce the power loss, commonly employ a small number of poles, such as 6 poles and 8 poles. Due to the small pole numbers, the widths of the magnets under each of the magnetic poles of the rotor are relatively large, and thus large centrifugal forces are generated, which is adverse to the high speed operation of the electric motors.

SUMMARY OF THE DISCLOSURE

[0003] In view of the above problems, the present disclosure provides a permanent magnet electric motor, to solve the problems of the conventional electric motors that the power loss is relatively large and high speed operation is difficult.

[0004] To achieve the above objects, the technical solutions of the present disclosure are realized as follows:

The present disclosure provides a permanent magnet electric motor, which is a radial flux electric motor and consists of a stator and a rotor, wherein an inner circle of the stator is provided with N stator teeth evenly in circumferential direction, each of the stator teeth is wound by a coil, and the N coils form stator windings, wherein, the N is an integer not less than 12; and the stator is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is an amorphous magnetic conductive material.

[0005] Optionally, the amorphous magnetic conductive material is an iron-based amorphous alloy.

[0006] Optionally, the rotor is manufactured by lami-

nating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is silicon steel; and

5 an outer circle of the rotor is provided with M magnetic poles evenly in circumferential direction, L rotor slots are provided under each of the magnetic poles, and each of the rotor slots is provided with 1 magnet embedded therein, wherein, the M is an even number not less than 12, and the L is an integer not less than 1. Optionally, directions of the magnetic poles of the magnets are perpendicular to or inclined to the radial directions of the rotor.

[0007] Optionally, the stator windings employ a concentrated winding.

The advantageous effects of the present disclosure are: 15 the present disclosure provides a permanent magnet electric motor, which is a radial flux electric motor, consisting of a stator and a rotor, wherein an inner circle of the stator is provided with N stator teeth evenly in circumferential direction, each of the stator teeth is wound by a coil, and the N coils form stator windings, wherein, the N is an integer not less than 12. Additionally, the number of the magnetic poles is not less than 12 so that widths and centrifugal forces of the magnets under each of the magnetic poles are limited, thereby facilitating the 20 high speed operation of the electric motor and improving the safety. The stator is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is an amorphous magnetic conductive material, whose power loss in an 25 alternating magnetic field is lower than that of silicon steel, which hugely increases the efficiency of the electric motor.

[0008] The above description is only an overview of the technical solutions of the present disclosure. In order 35 to understand the technical means of the present disclosure more clearly, and to implement them according to the contents of the description, and in order to make the above and other objects, features and advantages of the present disclosure more fully understood, the special embodiments of the present disclosure are provided below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other advantages and benefits will become 45 clear to a person skilled in the art by reading the detailed description of preferable embodiments below. The drawing is only for the purpose of illustrating the preferable embodiments, and is not considered as limitation to the present disclosure.

[0010] Fig. 1 is a schematic diagram of structure of an 50 electric motor of an embodiment of the present disclosure.

[0011] In that, 1 denotes a stator, 2 stator slots, 3 a 55 rotor, 4 rotor slots, 5 magnets, 6 a rotating shaft and 7 stator teeth.

DETAILED DESCRIPTION

[0012] The exemplary embodiments of the present disclosure will be described in further detail below by referring to the drawing. Although the drawing illustrates the exemplary embodiments of the present disclosure, it should be understood that, the present disclosure can be implemented in various forms, which should not be limited by the embodiments illustrated herein. In contrast, the purpose of providing those embodiments is to clearer understand the present disclosure, and to completely convey the scope of the present disclosure to a person skilled in the art.

[0013] As shown in Fig. 1, the embodiment of the present disclosure provides a permanent magnet electric motor, which is a radial flux electric motor, consisting of a stator 1, a rotor 3 and a rotating shaft 6. The rotor 3 is installed on the rotating shaft 6, and can drive the rotating shaft 6 to rotate. An inner circle of the stator 1 is provided with N stator slots evenly in circumferential direction, wherein, the N is an integer not less than 12. In a special embodiment of the present disclosure, the N is 18. The stator slots 2 are opened slots and are located at the edge of the inner circle of the stator 1, and the openings are facing the rotor 3. Two adjacent stator slots 2 form one stator tooth 7, each of the stator teeth 7 is wound by a coil (not shown in the figure), a span of each of the coils is one tooth pitch, the N coils form stator windings, and the stator windings employ a concentrated winding. The concentrated winding facilities increasing the inserting speed of the windings, and reducing the heights of the ends of the windings.

[0014] In the embodiment of the present disclosure, the stator 1 is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is an amorphous magnetic conductive material. In an embodiment of the present disclosure, the amorphous magnetic conductive material is an iron-based amorphous alloy. The power loss of the amorphous magnetic conductive material in an alternating magnetic field is lower than that of silicon steel, which hugely increases the efficiency of the electric motor, especially when the electric motor is running at a high speed.

[0015] The rotor 3 is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is silicon steel. An outer circle of the rotor 3 is provided with M magnetic poles in circumferential direction, L rotor slots 3 are provided under each of the magnetic poles, and each of the rotor slots 3 is provided with one magnet 5 embedded therein, wherein the number M of the rotor slots is an even number not less than 12, and the number L of the rotor slots under each of the magnetic poles is an integer not less than 1. In the embodiment of the present disclosure, the rotor is provided with totally 12 magnetic poles, 2 rotor slots are provided under each of the magnetic poles, each of the rotor slots is provided with one magnet

5 embedded therein, and there are totally 24 magnets. Here, the number of the magnetic poles refers to the number of the magnetic fields that are provided in the rotor, wherein each two magnets form an intensified magnetic field. It should be noted that, both the number M of the magnetic poles and the number L of the rotor slots under each of the magnetic poles can be freely set as required. The directions of the magnetic poles of the magnets 5 are inclined to the radial directions of the rotor 3, and two magnets under each of the magnetic poles are symmetrically arranged. The magnetic fluxes of the magnets under each of the magnetic poles converge and then pass through the air gap between the stator and the rotor to reach the iron core of the stator. It can be understood that, the directions of the magnetic poles of the magnets may also be perpendicular to the radial directions of the rotor.

[0016] In the embodiment of the present disclosure, the number of the magnetic poles is 12, and the number 20 of the magnets is 24. With the rotor of a same size, the number of the magnetic poles is relatively larger so that the widths and the centrifugal forces of the magnets 5 under each of the magnetic poles are limited, thereby facilitating the high speed operation of the electric motor and improving the safety of the electric motor.

[0017] In conclusion, the advantageous effects of the embodiments of the present disclosure are: the present disclosure provides a permanent magnet electric motor, which is a radial flux electric motor, consisting of a stator and a rotor, wherein an inner circle of the stator is provided with N stator teeth evenly in circumferential direction, each of the stator teeth is wound by a coil, and the N coils form stator windings, wherein, the N is an integer not less than 12. Additionally, the number of the magnetic poles of the rotor is not less than 12 so that the widths and the centrifugal forces of the magnets under each of the magnetic poles are limited, thereby facilitating the high speed operation of the electric motor and improving the safety. The stator is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is an amorphous magnetic conductive material, whose power loss in an alternating magnetic field is lower than that of silicon steel, which hugely increases the efficiency of the electric motor.

[0018] The above descriptions are merely preferable embodiments of the present disclosure, and are not limiting the protection scope of the present disclosure. Any modifications, equivalent substitutions or improvements 50 that are made within the spirit and principle of the present disclosure are all included in the protection scope of the present disclosure.

55 **Claims**

1. A permanent magnet electric motor, which is a radial flux electric motor, consisting of a stator (1) and a

rotor (3), **characterized in that**:

an inner circle of the stator (1) is provided with N stator teeth (7) evenly in circumferential direction, each of the stator teeth (7) is wound by a coil, and the N coils form stator windings, wherein, the N is an integer not less than 12; and
the stator (1) is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is an amorphous magnetic conductive material. 5

2. The permanent magnet electric motor according to claim 1, **characterized in that**: the amorphous magnetic conductive material is an iron-based amorphous alloy. 15
3. The permanent magnet electric motor according to claim 1, **characterized in that**: the rotor (3) is manufactured by laminating a plurality of annular thin sheets with a same shape, and the material of the annular thin sheets is silicon steel; and
an outer circle of the rotor (3) is provided with M magnetic poles evenly in circumferential direction, L rotor slots (4) are provided under each of the magnetic poles, and each of the rotor slots (4) is provided with 1 magnet (5) embedded therein, wherein, the M is an even number not less than 12, and the L is an integer not less than 1. 20 25 30
4. The permanent magnet electric motor according to claim 3, **characterized in that**: directions of the magnetic poles of the magnets (5) are perpendicular to or inclined to the radial directions of the rotor (3). 35
5. The permanent magnet electric motor according to claim 1, **characterized in that**: the stator windings employ a concentrated winding. 40

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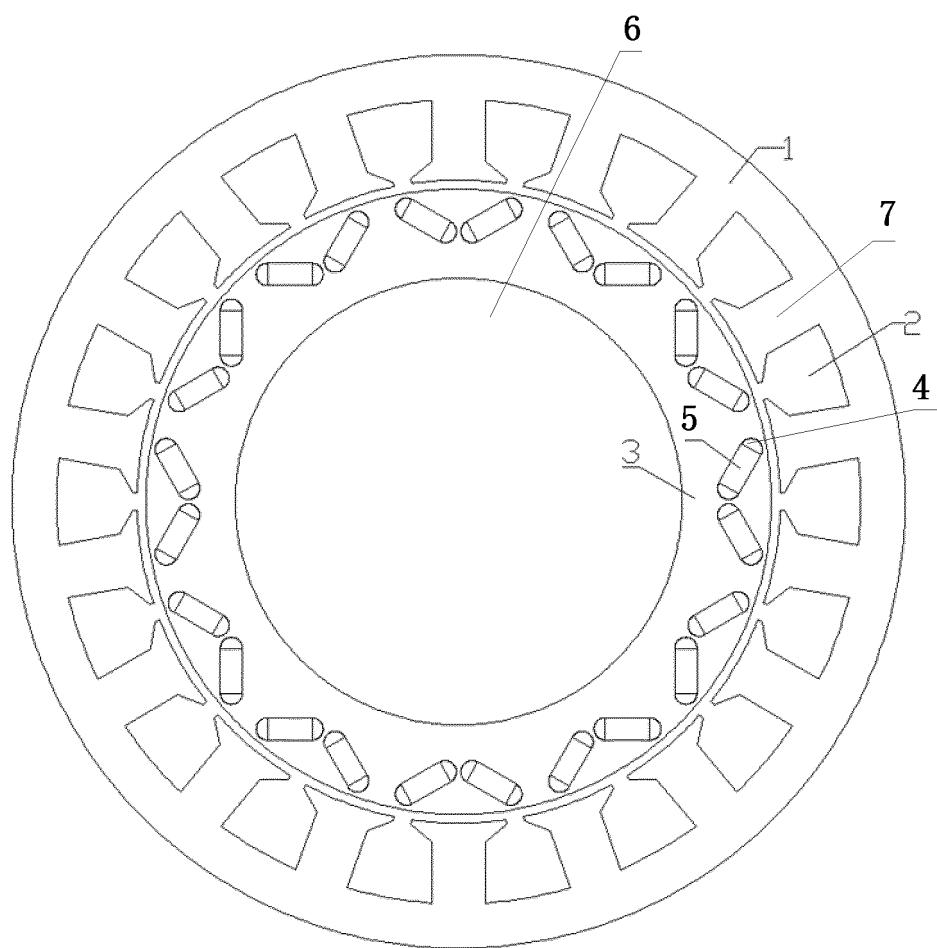


Fig. 1

INTERNATIONAL SEARCH REPORT		International application No. PCT/CN2017/071846	
5	A. CLASSIFICATION OF SUBJECT MATTER		
	H02K 21/14 (2006.01) i According to International Patent Classification (IPC) or to both national classification and IPC		
10	B. FIELDS SEARCHED		
	Minimum documentation searched (classification system followed by classification symbols) H02K		
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNPAT, WPI, EPODOC, CNKI: motor, permanent magnet, stator, rotor, tooth, groove, coil, winding, amorphous magnetic conductivity, iron-based amorphous, magnetic pole, magnet, incline		
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	
25	PX	CN 105896862 A (JING JIN ELECTRIC TECHNOLOGIES BEIJING CO., LTD.), 24 August 2016 (24.08.2016), claims 1-5	1-5
	PX	CN 205583967 U (JING JIN ELECTRIC TECHNOLOGIES BEIJING CO., LTD.), 14 September 2016 (14.09.2016), claims 1-5	1-5
	X	CN 102403852 A (SHANDONG UNIVERSITY, WEIHAI), 04 April 2012 (04.04.2012), description, paragraphs 0026-0040, and figures 1-3	1, 2, 5
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	Y	CN 101741158 A (FORD GLOBAL TECHNOLOGIES, LLC), 16 June 2010 (16.06.2010), description, paragraphs 0042-0095, and figures 1-24	3, 4
35	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
40	Date of the actual completion of the international search 15 February 2017 (15.02.2017)	Date of mailing of the international search report 15 March 2017 (15.03.2017)	
45	Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer XU, Zhenxia Telephone No.: (86-10) 62411785	
50			
55	Form PCT/ISA/210 (second sheet) (July 2009)		

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2017/071846

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005051982 A (ASMO CO., LTD.), 24 February 2005 (24.02.2005), description, paragraphs 0018-0050, and figures 1-6	3, 4

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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5	Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
10	CN 105896862 A	24 August 2016	None	
	CN 205583967 U	14 September 2016	None	
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